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Presenter

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Presenter's biography

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Ebba Dellwik is currently a senior scientist in the Remote sensing and meteorology section at DTU Wind Energy. She studied Engineering physics at Chalmers University of Technology in Gothenburg Sweden and got her PhD at DTU concerning forest meteorology in 2004. She started working on wind energy related projects shortly thereafter. Her current research is focused on how to optimally integrate lidar scans as surface description input in CFD models and on CFD model validation. Another reserach interest concerns wind lidars and in-situ anemometer measurement precision.

Abstract

Aerial LIDAR scans for validation of CFD models in complex forested terrain

Introduction

Around 95% of the current European wind energy is produced on land and it has been estimated that roughly three quarters of the new wind projects are located in forested areas. Forested sites are associated with high turbulence levels and reduced wind speeds compared to more open terrain, leading to high loads on the turbine. It is therefore important that a potential site is correctly evaluated in order to determine if the project is economically viable. To achieve an accurate site assessment, it is necessary to parameterize the effect of the forested landscape on the wind field and use wind models that can reproduce the observed spatial variation of the mean wind speed and turbulence intensity.

Approach

This study demonstrates a new automated approach to derive accurate and highly variable parameterization of both the forest and the ground roughness using data from airborne scanning lidars. We use the raw data from these lidars, the so-called point cloud, and derive maps suitable for state-of-the-art wind models. We further demonstrate how the wind models produce wind maps that reflect the variability of the forest. We validate the results from our wind model using multi-mast and multi-sodar/lidar measurements at two locations. Finally, we discuss current limitations to the approach and how to move forward.

Main body of abstract

Recent advances in lidar scanning technology have caused a strong growth in airborne measurements for characterizing the land surface. These scans are often carried out for whole countries for a multitude of earth science applications. We demonstrate a simplified method for characterizing the vertically resolved forest density suitable for large areas, and implement and test new parameterization of the ground roughness. To create the surface maps needed for the simulations we have made our treatment of the point-cloud more efficient, parallel and automated.

The approach was evaluated at two locations in Sweden. At one location, seven towers in a 12 x 6 km2 large area in moderately complex terrain represented the main infrastructure. The towers were equipped with cup anemometers at several levels. Data were post-processed and quality controlled to eliminate periods when the anemometers were frozen. The second location is a forested ridge site. In addition to a 180 m tall tower, equipped with both cups and sonic anemometers, six sodars and three wind lidars were placed along a 10 km long transect over the ridge. Near-neutral data from both locations were selected for comparison with the flow model predictions.

We use the EllipSys3D code, which is a CFD solver designed for wind energy applications, to predict mean wind speed and turbulence intensities at the two Swedish locations.

Conclusion

The computational cost of running the model poses a limitation to users who do not have access to a computer cluster. The current flow model limitation to near-neutral conditions also means that the method needs development to predict the full wind climate for a site. Nevertheless, the comparison between model and observations shows that flow modelling with detailed canopy and surface information data catches many of the characteristics seen in the observations. Furthermore, the uncertainty in determining the effect of the forest on the flow is reduced compared to previous methods. The main conclusion is that even though the flow models still need to develop, the inclusion of explicit canopy data reduces the uncertainty and further connects the models to reality.

Learning objectives

The delegates will learn (1) of a new way to do wind resource modeling in forested terrain and that the laser-data behind the presented approach is becoming increasingly available, (2) that the laser-data can be treated to create maps of all necessary surface characteristics needed for wind resource modeling and (3) the current limitations of the approach as well as of our future research and development focus.